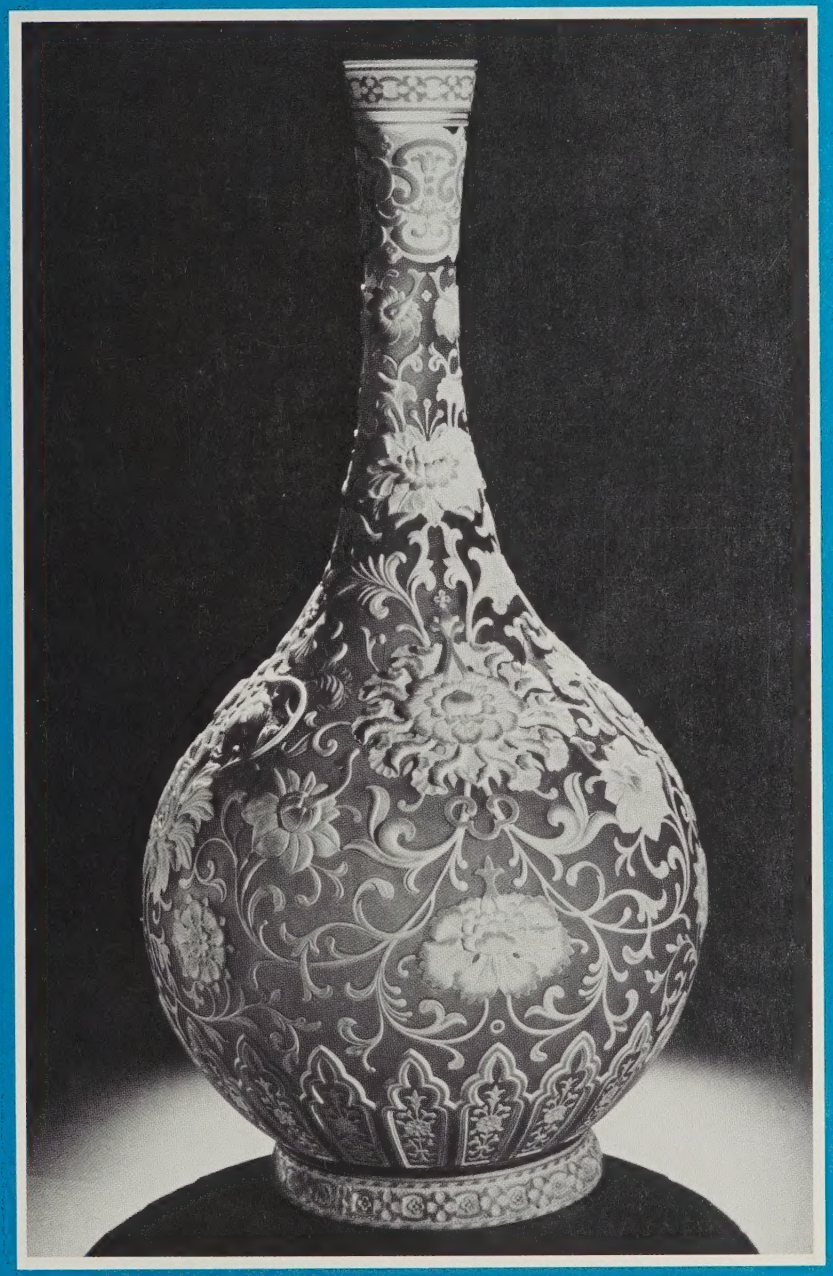
A GATHER OF GLASS

Glass through the ages in the Royal Ontario Museum

ROM



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Edited by C. Peter Kaellgren

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Royal Ontario Museum
100 Queen's Park, Toronto, Canada M5S 2C6

ISBN 0-88854-205-4

Design by Virginia Morin

Typeset by Neographix
Printed and bound in Canada by
M&S Printers Limited

Photography by William B. Robertson,
Assistant Head Photographer, ROM.

Special thanks to: Mrs. Marion Blake,
Dr. Robert I. Gait, Mrs. G.G.R. Harris,
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The front and back covers show different approaches to art glass, that is, glass made as an ornamental art form. The vase on the front cover was carved after cooling, while the horse was sculpted from hot glass. Front cover: Vase, "cameo glass". Pale blue body with layers of white and pale pink. English, Thomas Webb & Sons, Stourbridge, about 1880. The design of stylized flowers derives from Ming blue and white porcelains by way of Persian or Indian decorative arts. H. 46.5 cm. 928.18.17. Back cover: Horse, figurine worked "off hand" (with tools while the glass is hot). Pale aquamarine lead glass. Czechoslovakian, Železný Brod Glassworks, by Miloslav Klinger, 1974. Gift of Mr. J. Markovic. H. 28 cm. 977.31.1

Introduction

Vase, moulded opalescent glass. Engraved on bottom "R. LALIQUE FRANCE" and etched "No 997". This model, made about 1922-30, was known as the Bacchantes vase, and is still being produced in clear lead glass with a frosted finish. Gift of Mrs. F.N.G. Starr. H. 24.2 cm. 950.82.17

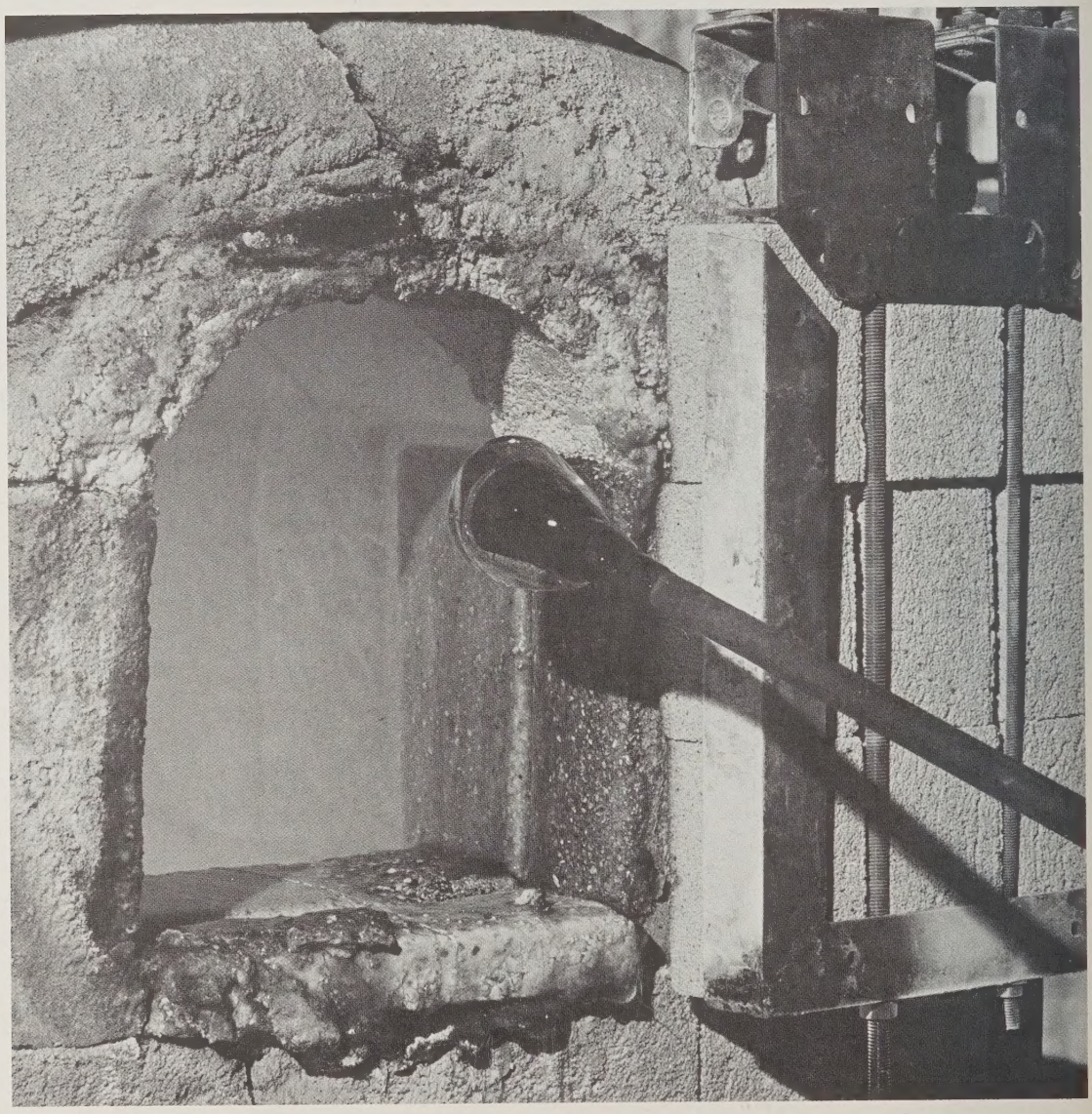
The versatility and unique optical properties of glass have fascinated mankind almost since the beginning of civilization. The history of melted and worked glass can be traced back 3,500 years. From the earliest civilizations onwards, glass was an important article of commerce and was often traded over great distances, especially in the form of beads. Advances in glassmaking methods can be traced from country to country and provide an illuminating chapter in the history of technology. Styles in glassmaking, too, were transmitted, though certain cultures have become famous for their own distinctive national and period styles.

The social uses and forms of glass objects are as varied as the cultures that have created them — from the intricate snuff bottles of Ch'ing Dynasty China to the no less finely crafted glass lenses used in modern scientific instruments. In its most familiar forms, such as containers and drinking vessels, glass is a medium that demonstrates how the style and aesthetics of an age can be expressed through utilitarian objects.

The Royal Ontario Museum's collection of about 5,000 glass objects represents the entire spectrum of mankind's use of glass through the ages. Its artifacts include early examples of chipped obsidian (volcanic glass) tools, crudely worked glass from ancient Egypt, sophisticated vessels from the Greek and Roman period, Islamic glass, Chinese glass (often worked to resemble gemstones), and the later European, English, American, and Canadian glass. Other dimensions are provided by beadwork from both civilized and tribal cultures, glass novelties, and contemporary art glass.

"A Gather of Glass", the exhibition that opens on October 6, 1977, at the Royal Ontario Museum, documents the use of glass from earliest times to the present, and provides visitors with a unique opportunity to see and compare the finest examples from the Museum's extensive collections.
"A Gather of Glass" is also one way in which the Museum can honour the many persons whose generous gifts have helped build its glass collections. Most of these benefactors are acknowledged at the end of this survey.

A gather of glass being removed from the furnace in the glass studio at Harbourfront, Toronto. An iron rod (pontil) or a hollow iron blow-pipe is used to remove glass from the melting pot. The molten glass gathers around the end of the rod as it is stirred. This accumulation of glass is known as a "gather".



Glassmaking

Glass is an inorganic substance which is the product of fusion (melting). It is basically a super-cooled liquid, that is, a material that has solidified without crystallizing. Although it resembles certain crystals, its molecular structure is not as organized as that of a crystal. It can have a variety of properties depending on its chemical components. It is chemically inert to most liquids, and can be a good insulation against electricity. Most varieties are brittle, and all fracture in straight lines with flakes.

About seventy-five per cent of the composition of glass is silica (silicon dioxide SiO_2), which is most readily available as sand. High-quality white sand with uniform small grains and a minimum of organic matter is preferred in glassmaking. Silica by itself can be fused at about 1850°C, a temperature which is only viable commercially when a high-quality product is required. Some other chemical compound, called a flux, is used to lower the melting point to about 1300°C. The flux can be sodium carbonate (Na_2CO_3), which is known as soda; potassium carbonate (K_2CO_3), known as potash; or lead oxide (PbO). Each of these materials produces a glass with its own distinctive qualities. Soda glass is ideal for elaborately tooled work, like that of early Venetian glass, and lead oxide produces a heavy glass of high brilliance which can be enhanced by cutting. To stabilize the material, about ten per cent of lime (CaO) in the form of limestone or chalk is added to the ingredients. A measured quantity of cullet or broken glass of the same type is mixed in to facilitate melting. Other chemicals and colouring agents may be added in controlled quantities, such as white oxide of arsenic, which improves the brilliance and clarity of the glass.

In ovenware or pyrex glass, boric oxide (B_2O_3) is substituted for lime. This produces a glass that expands less and therefore undergoes fewer stresses when heated. The boric oxide also increases the ability of the glass to conduct heat. These features make borosilicate glass ideal for ovenware and laboratory equipment.

The colours in glass are created in several ways. In certain cases they are due to minute particles of material distributed throughout the body of the glass. Some examples are gold, copper, and cadmium selenide, used to produce ruby glass, and cadmium sulphide or sulphoselenide, which gives certain yellow and orange colours. Other glass colours, such as the blue created by cobalt or copper, are created by ions dissolved in the glass. Shades of green result from iron, copper oxides, or potassium dichromate. Amber is produced by carbon and sulphur, iron and manganese, or iron oxide with charcoal.

The glassmaking ingredients are mixed and melted in pots of specially fired clay, which can range in capacity from a few pounds to 3,000 pounds, or in a heated tub. The batch is melted in stages, with additional ingredients added as more melts. The enclosed furnace is usually fired by gas or electricity to a temperature of 1,350-1,450°. Carbon dioxide and sulphur trioxide are produced as residues of the melting process.

When glass is hot, it can be worked in various ways. Because it is so malleable it can be rolled into sheets, or, at the other extreme, stretched out in threads. Certain formulae, such as the lead oxide formula, give a longer period of workability.

Although most glass is mass-produced by being mechanically pressed or blown into moulds, basic tools that have changed little since Roman times are still used for blowing and working glass by hand. These include the pontil (an iron rod used as a handle for manipulating glass), the blow-pipe, shears, moulds for blowing basic forms, pincers, the marver (a flat surface for rolling the glass smooth), and various forming tools. In hand-work, the iron blow-pipe or the pontil rod is dipped through a hole in the side of the furnace into the glass pot. Molten glass gathers around the end of the iron, and the tool is withdrawn when enough glass has been collected. If a piece requires much tooling or added ornament, the glass may have to be periodically reheated at the mouth of the furnace in what is called a "glory hole" to keep it soft for working. When the piece is finally completed, it is allowed to cool gradually in the annealing oven. Then it may be finished by grinding smooth the scar where the pontil held it during manipulation. Engraving, acid etching, enamelling, and gilding are some of the many techniques that can be used to decorate the finished glass.

Ancient Glass

Dagger, obsidian blade with incised wooden handle thickly painted with natural pigments in red, black, and white. Melanesian, Admiralty Islands, probably nineteenth century. L.29.5 cm. HB 1512

The first glass to be used by man was obsidian, a naturally occurring form of volcanic glass somewhat harder than window glass. Its high iron content gives it a smoky colour. A core of obsidian can be flaked into long, thin cutting blades for implements and may be chipped to form sharp points. Obsidian was traded over great distances in both the Old World and the New, and was especially valued for its cutting properties in societies without metal. It is still fashioned into jewellery. The pre-Columbian peoples of Central America even polished slabs of obsidian for use as mirrors.

Though little is known about the discovery of glassmaking, it probably occurred in northern Syria. Vessels, figures, and beads with vitreous glazes are known from the fifth millennium B.C. These are often composed of a small clay or stone core with a heavy covering of raw siliceous materials which have been partially melted. This proto-glass is known as faience and is usually found in shades of blue and green.

The first true glass dates from the Eighteenth Dynasty in Egypt, about 1484 B.C. It was worked in two ways: by being poured into moulds, or by being built up over a core composed of sand and clay. The core was dipped in molten glass and/or trailed with ribbons of molten glass. The hot trails of contrasting coloured glass were often manipulated on the surface to give a wavy effect. This is known as combing or dragging. The vessel was then rolled on a flat surface (marver) to smooth the exterior. Necks, handles, and feet were applied, and the piece was allowed to cool before the core was chipped out. Because the process was so laborious, production was limited to small cosmetic jars and cups. Amulets and beads were probably core-wound over a wire. Like many ancient peoples, the Egyptians produced glass to simulate semi-precious stones such as jasper and lapis lazuli. Between the Eighteenth Dynasty and about the third century B.C., the glassmaking industry appears to have lapsed in Egypt.

Vessel, core-wound glass. Dark blue overlaid with "dragged" decoration in yellow and white. Egyptian, second half of Eighteenth Dynasty (1450-1320 B.C.). Gift of Miss Helen Norton. H. 9.6 cm. 951.1.4

Greek and Roman Glass

Small core-formed containers have been found in sites inhabited by Greek-speaking people from the early sixth century B.C. onward. Apparently these vessels were produced in Asia Minor (western Turkey). Glassmaking seems to have been important in Phoenicia (modern Syria) and Egypt from the third century B.C. From about 250 B.C., open vessels were cast in moulds and polished on a lathe when cool. Other vessels were constructed of cross sections of glass canes. The glass canes were used to line a mould and were then melted with other glass between them to form the vessel. The canes were also used for making fancy beads and elaborate mosaic plaques. Canes were built up by dipping a glass rod in molten glass of different colours to build up a layered effect, or by heating differently coloured glass rods arranged in a pattern so that they melted into one solid rod. The glass could be tooled while hot, and when the desired pattern had been created, the hot cane was pulled out to the required diameter, thus reducing the design in size. The internal patterns in these canes often resembled flowers. For this reason, vessels made with cross sections of canes are referred to as a millefiori (thousand flowers) glass. The core, casting, and millefiori casting techniques were all laborious.

About the beginning of the Christian era, glass-blowing techniques came into use and made production faster and easier. As a consequence glass became cheaper and could be made in a far wider range of shapes, although the earlier laborious techniques continued to be used for luxury articles until the early second century A.D. The Romans preferred clear glass or "crystallum" that resembled rock crystal (quartz), and their tablewares frequently copied shapes in metals and earthenware. A cheaper, greenish ware known as Judean was also extensively produced, and much glass was also made in colour. Vessels were blown into moulds to produce novelty shapes, especially in the area of Sidon (Syria/Israel/Palestine). Cast medallions and tooled and trailed decoration were employed. Engraved gold foil was sandwiched between layers of glass, notably for portraits. Cutting was used to produce effects ranging from crude surface decoration to layered glass of white over blue or other colours cut in cameo, as well as cups with elaborate cagework on the exterior.

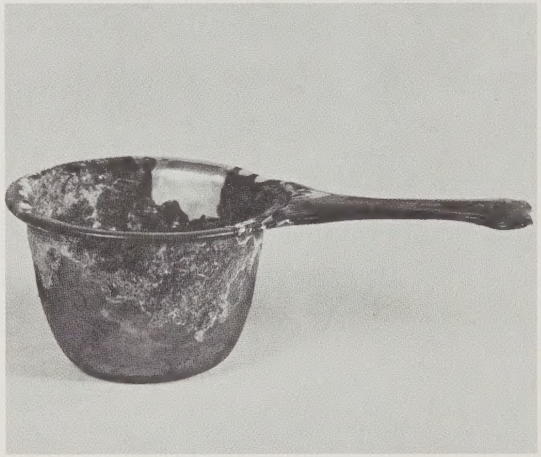
Beads, glass paste with glass mosaic inlays. Roman Egypt, first to early second century A.D. Diam. 1.5 cm. 963.118.1-3

This classical period was remarkably rich in glass. In fact, during the first four centuries A.D., the Romans used almost every known glassmaking technique with the exception of acid etching and lead glass. In 301 A.D., the emperor Diocletian set the price of a pound of cheap green Judean glassware as being equal to that of 1¼ pounds of butter or 2½ pounds of beef or the day's pay (with food provided) for a shepherd. Glassware was widely traded and, before the advent of Christianity, was extensively used for tomb offerings. This accounts for the survival of such quantities of classical glass.

Much ancient glass has an iridescent appearance as a result of surface decay during burial. The iridescence is created when light rays are broken up in the decayed layers. Glass from dry climates or from

uniformly moist sites, like shipwrecks, displays little surface decay.

With the disintegration of the Roman Empire in the fourth century, the glassmaking industry also dispersed. By the third and fourth centuries, itinerant Syrian and Jewish workers had set up workshops as far away as the Rhineland. Glassmaking had largely died out in Western Europe by the sixth century. The later products, like those which continued to be produced in Egypt, were of poorly prepared materials with numerous bubbles and impurities. The glassworkers of the Middle Ages were predominantly Jewish, partly because Christians often superstitiously feared that the transformation of sand and soda into glass by fire was the work of the devil. The industry in the Syria-Palestine area continued to produce a good deal of quality glass but the range was limited mainly to flasks, drinking cups, and lamp glasses for candelabra. With the Islamic conquest of the Middle East in the seventh century, glass-making centres in Western Europe were deprived of raw materials and were forced into a decline, and Islamic workshops rose to pre-eminence.



Bowl with flat handle ("trulla"), yellowish green glass with iridescent decay. Roman Syria, second century A.D. Related to a popular metalware form. Gift of Miss Helen Norton. L. (with handle) 18.2 cm. 950.157.79

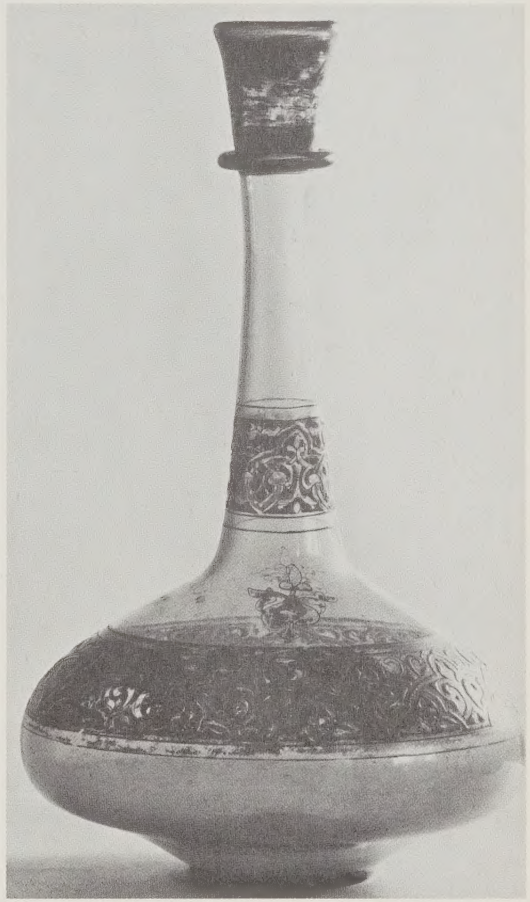
Bottle, mould-blown blue glass. Sidonian (Syrian), late third-fourth century A.D. Excavated at Gebel Adda in the desert of Nubia, this glass is relatively undecayed and still contains a rose scent. On permanent loan from the National Geographic Society. H. 8 cm. Adda 63:3:214

The Islamic World

The courts of the caliphs and sultans attracted migrant glass artisans working on commissions, who brought about a similarity of styles in widely scattered locations. These artisans produced blown glass with improved bases and rims, applied decoration, and tooled details including designs impressed by tongs. Engraving, relief cutting, and painting were employed to decorate the finished products. Lustrous designs in browns, yellows, and reds were painted on the inner and outer surfaces of glass. This decoration, which was favoured in Cairo from the eighth to the twelfth century, was produced by pigments of metallic oxides and other chemicals which were fired on in a kiln.

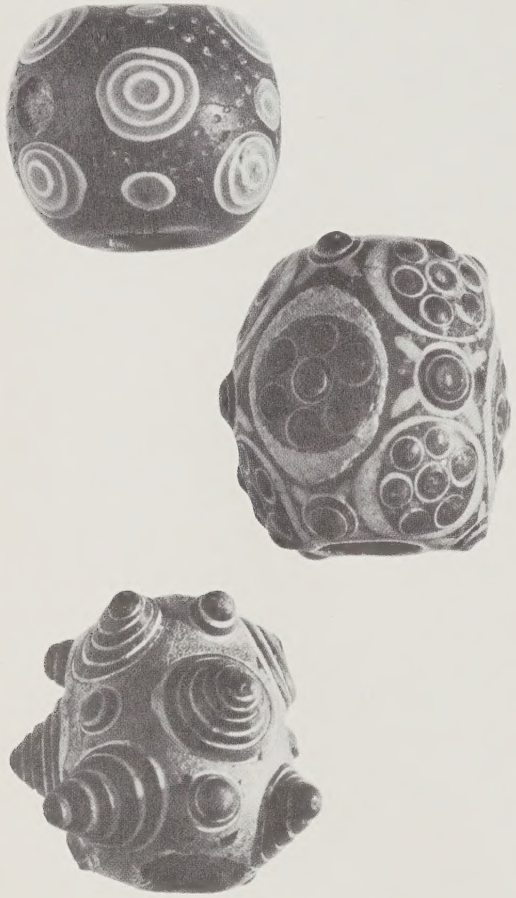
The most widely known of Islamic vessels are those with painted enamel decoration dating from the late twelfth through the early fourteenth century. Aleppo and Damascus in Syria were leading centres. They produced tumblers, bottles, cups, and mosque lamp shades with elaborate, stylized floral decoration and inscriptions. Some of these pieces found their way to places as far away as England and China, where they were treasured. In Islamic lands, glass was also used architecturally for window panes set in plaster grill-work and for millefiori glass wall plaques from ninth-century Samarra near Baghdad.

From the sixteenth century onwards, glass and other luxury goods were increasingly imported from Europe, where manufacturers often designed products specifically for the Eastern market. The only exceptions were certain pieces of bold and graceful design inspired by the patronage of Shah Abbas in sixteenth-century Persia. These were still being made in the eighteenth century. Glass-making has continued to the present day as a craft industry in many parts of the Middle East.



Bottle, transparent slightly yellowish glass. Arabesque designs painted in blue and white enamel and gilt. Syrian, Aleppo Group, about 1250-1300 A.D. Found in a mosque in Shansi Province, northern China. H. 27.2 cm. 924.26.1

Chinese Glass



Three "eye" beads, black, deep blue, turquoise, and opaque white glass. Chinese, late Eastern Chou, fifth-third century B.C. Note the acentric "horned" eyes on the example at bottom. Reported from princely burials of Old Loyang at Chin-ts'un, Honan Province. The Bishop White Collection. Maximum L. 2.8 cm. 933.12.10 abc

Several terms were used for glass in China. The first are believed to be approximations of foreign words and refer to the more opaque forms of glass and glaze, often used as substitutes for jade. This early glass was called *liu-li* or *pi liu-li* from the Han Dynasty (206 B.C. - A.D. 220) onward. *Po-li* was used in T'ang (A.D. 618-906) and later times to refer to clear glass, sometimes confused with rock crystal or quartz. The modern term for glass is *liao-chi*.

Glass was known and used in China at least as early as 1000 B.C. Glass and glazed beads believed to come from the princely tombs of Old Loyang at Chin-ts'un in Honan Province (fifth-third century B.C.) constitute the earliest evidence of Chinese glassmaking from the ROM's collections. The "eye" beads with their stratified round inlays resembling eyes (which sometimes project to form "horns") are the most distinctive. Stylistically they resemble examples from West Asia and the Mediterranean from around 500 B.C. Chinese examples can be distinguished from imports, however, by their high lead content, and especially by considerable amounts of barium oxide, which did not appear in Western glass until the nineteenth century. Plaques with similarly "eyed" decoration were set like jewels into metalwork. "Chinese faience" beads were also produced in pre-Han China.

Pale green glass or *pi liu-li* was used as a cheap substitute for jade to fabricate plaques for burial suits, plugs for the "nine apertures" of the body, pigs to be placed in the hands of the deceased, cicadas for the tongue, and the *pi* disks (with hole at centre) regarded as symbols of Heaven —all essential to the proper Han burial. The use of glass to simulate semi-precious stones, particularly for jewellery and later for the manufacture of snuff bottles, is a recurring theme in Chinese glass history. Because the Chinese were preoccupied with gemstones, they often treated glass with lapidary techniques even after the introduction of glass-blowing in the fourth or fifth century.

Chinese preferred materials other than glass for making vessels, and very few glass vessels can be dated prior to 1700. Bronze and jade were the most desirable in early times, and lacquer was favoured. Porcelain became pre-eminent later in China, especially for hot liquids such as hot wine and tea. The earliest glass vessels, of perhaps the third century B.C., were not blown but were apparently moulded on a clay core and decorated with the compound eye motif of the early beads. Some early vessels found in China were imported. Blown glass was probably not made there much before the fifth century A.D., and then neither in large quantity nor of fine quality. Three vessels in the ROM may be of T'ang date, though one of them was surely an import.

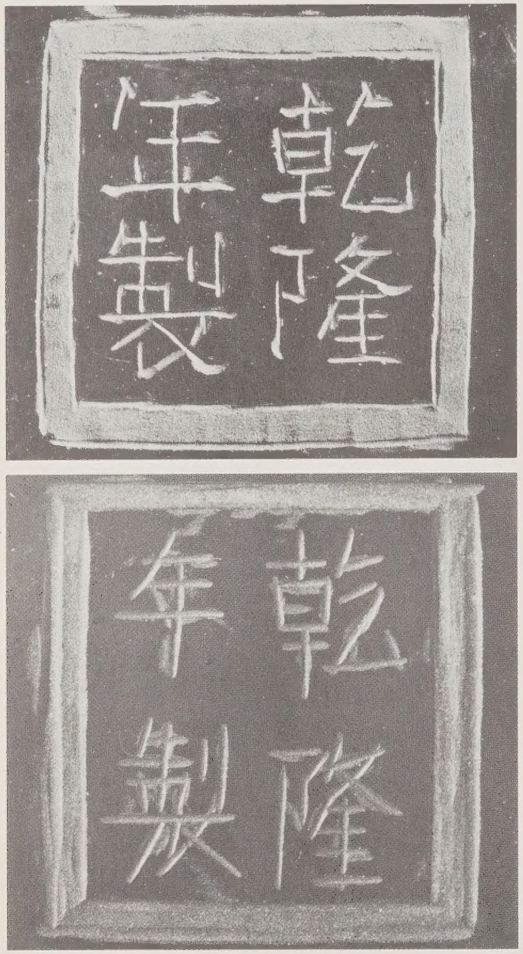
It was only with the establishment of an imperial glassworks in Peking in 1680, by decree of the emperor K'ang-hsi, that glass vessels gained some status in China. The factory was probably set up with the aid of Europeans, the Dutch Jesuit Ferdinand

Verbiest and a German padre, Kilian Stumpf. A large ribbed bowl in the ROM (with surface decomposed as in seventeenth-century European glass) may be an early product of this palace factory. Glass was also produced in the Po-shan district of Shantung Province, while Canton became known for window glass, spectacles, and beads.

Many Chinese glass vessels are thick and have an oily or waxy sheen. They are simple and strong in shape. Bottle vases with globular bodies and cylindrical necks, baluster vases, bowls, lobed dishes, and other pieces copying ceramic forms were favoured in late dynastic China. Their rich colours include blue, green, amber, emerald green, amethyst, and ruby. From about 1720 tin oxide (or calcium fluoride) was used as an opacifying agent and permitted another complete range of porcelain-like pastel colours. The most elaborate works in glass are those composed of two or more layers, usually clear-coloured glass over opaque white, with the outer layers carved to the body in varying degrees of relief. Works were finished with wheel polishing and facetting, and incised and engraved designs. Some pictorial designs were painted with coloured enamels on opaque white glass, giving it the appearance of porcelain. Interior painting was done chiefly on clear glass with unpolished or acid-dulled interiors.

The powdered aromatic blends of tobacco called snuff may have reached China as early as 1582. Snuff bottles probably summarize the range of techniques, forms, colours, and decorative devices of Ch'ing Dynasty (1644-1911) glass better than any other products of the industry. For the little snuff bottles alone glass was both the earliest and the most popular medium.

Cicada, tongue plaque for burial, moulded pale green glass with corroded surfaces. Chinese, Han Dynasty (206 B.C.-A.D. 220). Glass was used as a substitute for jade in such burial pieces. The Bishop White Collection. L. 5.5 cm. 933.12.11a



Like ceramics, Chinese glass was often given the mark of an earlier period. Experts can distinguish the genuine object that bears the genuine mark. Two examples of Ch'ien-lung marks (1736-96): Above: genuine mark from a bottle form glass vase. The George Crofts collection. 922.20.412. Below: early twentieth-century fake mark from a glass bowl. 920x86.6

Chinese glass vessels of the Ch'ing Dynasty (1644-1911). Emerald green plate, opaque yellow vase, blue petal dish, and small yellow bowl. The George Crofts Collection. Diam. of plate 33.2 cm. 922.20.12, .475 and .478 and 920x86.7 respectively

Chinese glass snuff bottles of the Ch'ing Dynasty (1644-1911). **1,** *clear red overlay on "camphor", carved with "Hundred Antiques" motifs; imitation jadeite stopper with ivory spoon. The George Crofts Collection. 922.20.533.* **2,** *cylindrical white glass bottle with enamel-painted scene and red stopper. Ch'ien-lung mark and period (1736-96). Loan from the Ontario Heritage Foundation ex coll. James W. Cochrane. H. 6.5 cm. L973.22.44.* **3,** *streaked black, white, and brown-grey glass imitating agate, red stopper, 1850-1920. The George Crofts Collection. 922.20.523*

Snuff bottle, clear glass, interior painted in Peking by Kuei Hsiang-ku and dated 1895. The George Crofts Collection. H. 5.5 cm. 922.20.602

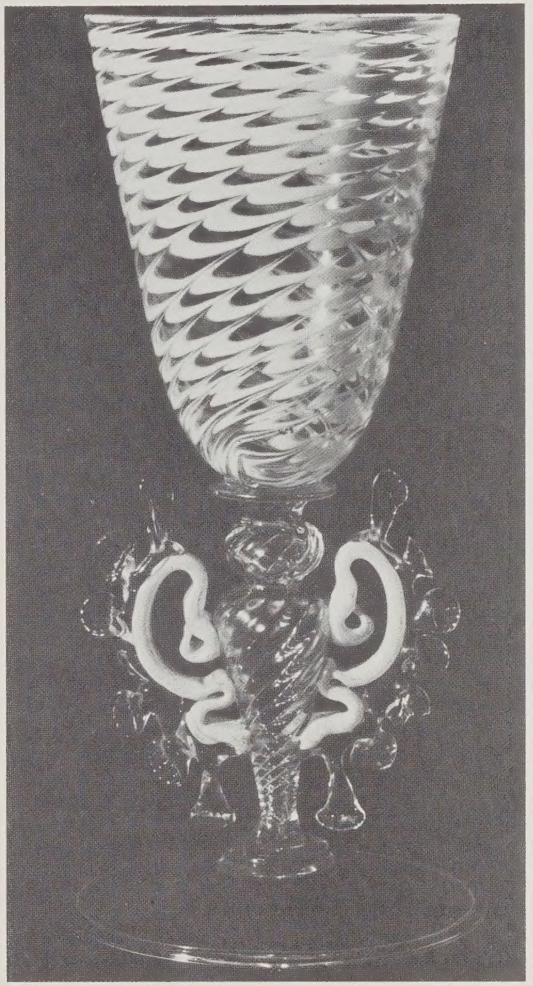
Pre-1800 Western Glass

In the West, glassmaking was revived in Venice, a leading mercantile power in the Mediterranean and a city well protected by its island location. Venetian glass manufacturing was established at least by the eleventh century. By the late thirteenth century, the glass furnaces had been moved to the nearby island of Murano, to lessen the danger of fire. Although the renowned Venetian glass was traded throughout Europe, the earliest surviving examples are datable only to the mid-fifteenth century. The early, coloured vessels were simply shaped, often with pictorial decoration in thick opaque enamels. The process of making "cristallo", a soda lime glass with a manganese decolourizor, was discovered in the fifteenth century. (A decolourizor is a colouring agent added in precise quantities to optically counteract the colour of impurities in the ingredients.) Venetian cristallo was thinly blown to eliminate the residual greyness of the manganese. Dotted patterns and gilding decorated the early examples.

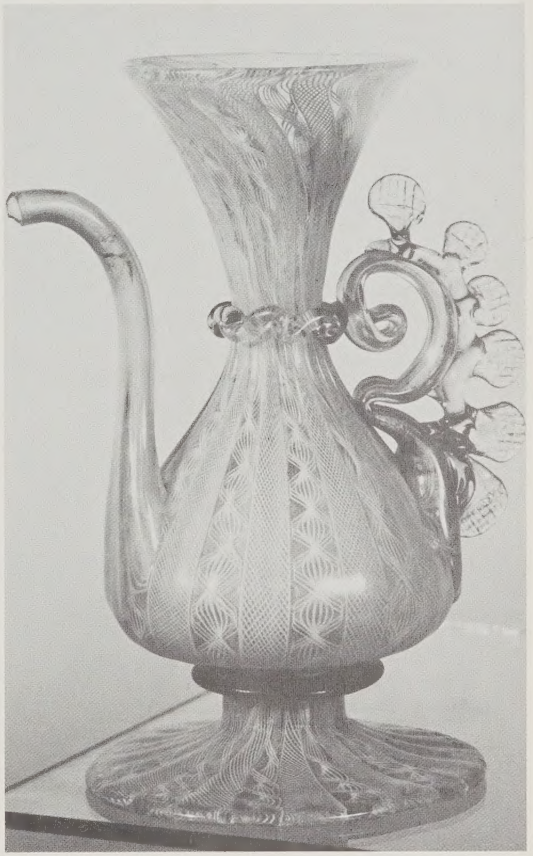
Trailed and pincered decoration largely supplanted enamelling in the late sixteenth century. Diamond point engraving was practised from the mid-sixteenth century onwards. Another invention of the same period was the use of tin oxide to produce solid white glass and filigree patterns of opaque threads. During this early period, the shape of the goblet changed from a flat-based bowl on a trumpet foot to a conical bowl on a well-defined hollow stem with a flattened foot.

Ewer, clear glass. Enamelled with red, white, and blue dots and gilt. Venetian, early sixteenth century. H. 17.3 cm. 959.6

Although Venetian workers were forbidden under pain of harsh penalties to reveal glass secrets, nonetheless many left to start rival industries in Western Europe during the sixteenth and seventeenth centuries. Other Italian workers came from Altare, another important glassmaking centre. As nationalistic styles and technologies evolved, the Venetian supremacy began to wane and had largely vanished by the early eighteenth century. With the exception of ornamental mirrors with intaglio cutting, fanciful chandeliers, and certain enamelled white glassware produced in the Miotti factory ca. 1730-50, Venetian glassmaking did not figure prominently again until the late nineteenth century.

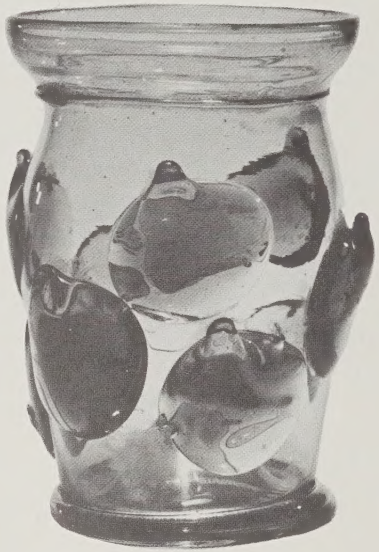


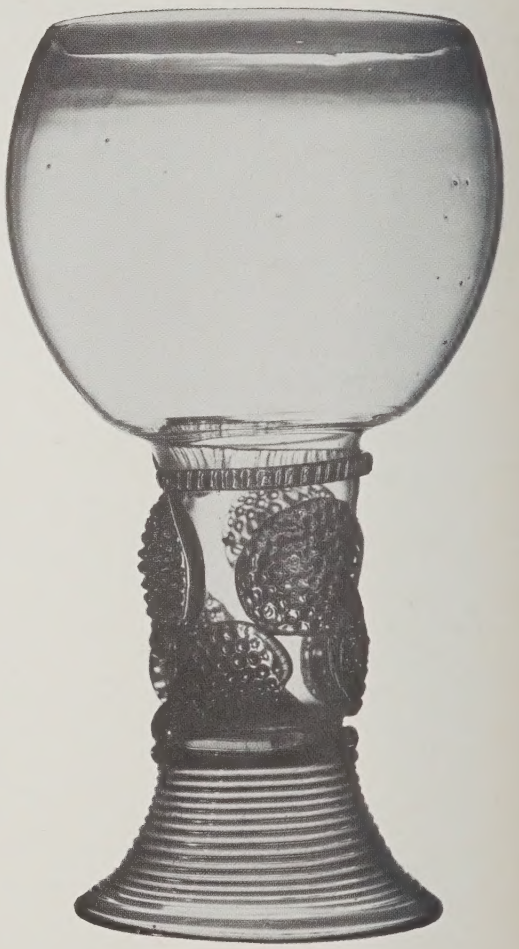
Goblet, funnel bowl with combed opaque white threads. Clear foot and stem with scrolled yellow wings with clear pincered "feathers". Venetian or "façon de Venise", first half of seventeenth century. H. 17.5 cm. 907.5.19



Ewer, body and foot of filigree glass with tooled additions in clear glass. Venetian or "façon de Venise", seventeenth century. H. 12.2 cm. 907.5.30

It was in Holland and Belgium that "façon de Venise" glass was most successfully produced. (Any Venetian-style glass that cannot be attributed to Venice is called "in the Venetian fashion".) Italian workers had started glasshouses in Antwerp and Liège by the mid-sixteenth century and at Amsterdam slightly later, and Venetian styles persisted until the late seventeenth century. Local adaptations included applied lion mask reliefs and goblets with elaborate serpent stems. Germanic influence can be seen in the roemer, a vessel for white Rhine wines. Diamond engraving was practised from the seventeenth century onwards. Early examples were linear, but in the eighteenth century a new technique of stippling developed. In the last decades of the century, the most notable exponent of this Dutch art was David Wolff, who usually did portraits on wine glasses. Wheel and diamond engraving were done mainly on imported English glass, which was of higher quality than the domestic product.



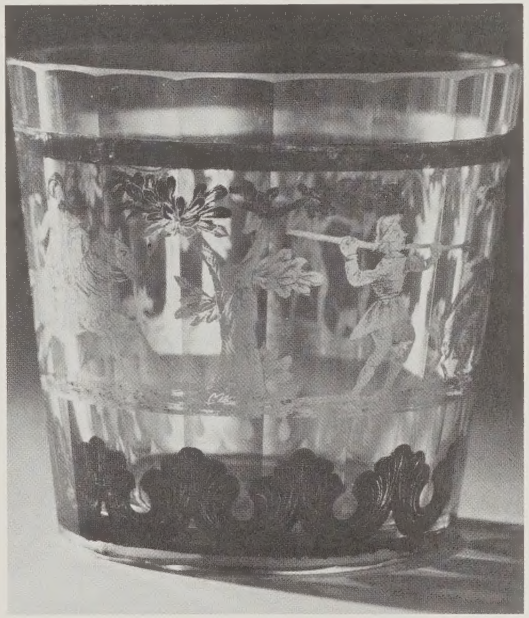


Forms evolve gradually over time. On the left is a "krautstrunk" or "cabbage stalk" beaker of pale green glass. The shape is so named because the applied drops of glass make it resemble a cabbage stalk with the leaves pulled off. Rhenish, late fifteenth-early sixteenth century. 971.81a. By the late seventeenth century, this pale green glass had evolved into the roemer of Germany and the Netherlands, with its full bowl and pressed and applied raspberry prunts (glass medallions). H. 11.4 cm. 965.241.1

In Central Europe, after the collapse of the Roman Empire, glass was a primitive industry confined to small furnaces in the forests which produced poor-quality green and brown glass, called "waldeglas" or forest glass. In the mid-fifteenth century glassmaking revived in the Rhineland. A typical vessel was the "krautstrunk", a small cylindrical glass with applied prunts (drops) simulating a cabbage stalk with the leaves removed.

Venetian workers began to set up glasshouses in the towns about 1550 and soon supplanted the waldeglas tradition. Venetian enamelling techniques were applied to produce robust Germanic designs on drinking vessels. Late in the seventeenth century, glass containing potash and large amounts of lime came into production in German and Bohemian areas. This glass was thicker and stronger, very suitable for cutting and wheel engraving, which were in turn influenced by local rock crystal and lapidary work. Decoration of remarkable quality was produced in the seventeenth and eighteenth centuries. Other developments included ruby glass, invented by the chemist Johann Kunckel of Potsdam in the late seventeenth century, and "schwarzlot" (painting in black enamel), which was practised by independent decorators from about 1650 to 1725. For a brief time Bohemia revived the ancient Roman technique of setting engraved gold leaf and enamel between two close-fitting glasses (zwischengoldgläser).

Central European styles of the late eighteenth century often copied the current vogue for English cut-lead glass. Enamel decoration was still used for poorer grades of glass and for opaque white glass, which was often produced in shapes derived from ceramics.

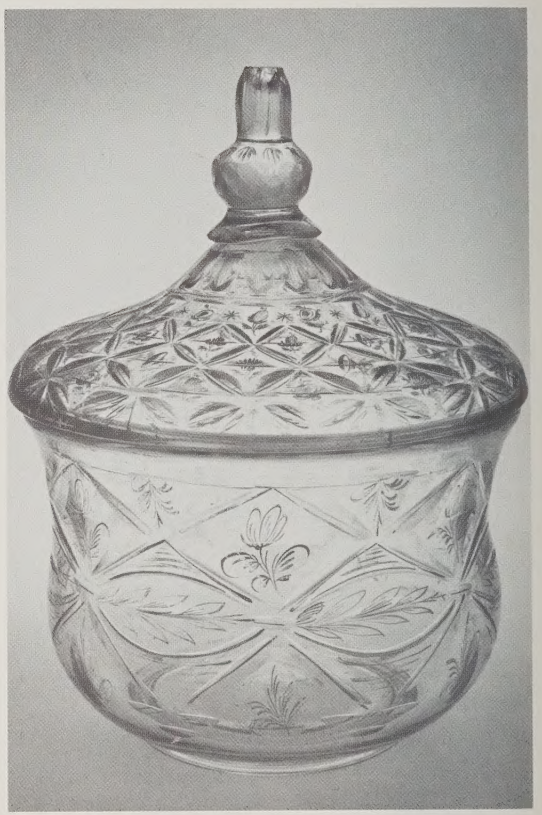


Tumbler, "zwischengoldgläser". Two layers of glass enclosing engraved gold leaf. Bohemian, 1730-40. H. 6.8 cm. 959.203.10

Tumbler, ruby-coloured glass with wheel engraving. South German or Nuremburg, late seventeenth century. H. 12 cm. 957.203.4

Though Spanish glass has rarely attained artistic or technical distinction, it reveals a wide variety of influences from other cultures. Glass from the south shows an Islamic taste in the use of colour and vigorous multiple-handled vessels. In the north, where there had been no Moorish occupation, Venetian fashions were copied, particularly in Catalonia. In 1728, a glasshouse under royal patronage was set up at La Granja de San Idelfonso in Castile to supply the market for more substantial colourless glass engraved in the Bohemian style. Initially, the glasshouse produced cut-glass chandeliers and mirrors, and later it introduced a full range of blown glassware. The glasshouse employed many foreign workmen, and both German and English influences are evident, although the cutting was never up to English standards. Enamelled glass closely resembling Bohemian was also used in eighteenth-century Spain. In 1829, San Idelfonso ceased to be a royal factory; and subsequently only common glass was made there.

"Cantir" (serving jug), yellowish amber glass with white threads and blue, tooled decoration. Spanish, Catalonia, early eighteenth century. Gift of Miss Helen Norton. H. 22 cm. 950.157.150

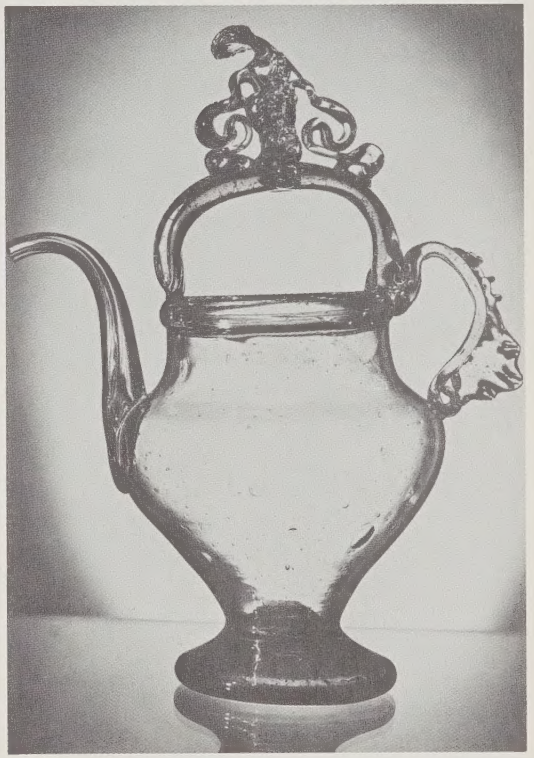


Covered bowl, cut non-lead glass. The gilt decoration is typical of Spanish glass. La Granja de San Idelfonso, early nineteenth century. Gift of Mrs. R.Y. Eaton. H. 27 cm. 945.20.71a-b

Apart from beautiful mediaeval stained glass, and mirror plate glass which began to be produced in the late seventeenth century, glass manufacture in France lagged behind important international developments. Though Italians set up factories in France in the late fifteenth century, the output of façon de Venise glass was minimal. Most glass was imported from Venice and later from Germany and England. Lampwork figurines of humans and animals, built up from coloured rods of glass heated over a lamp and added to a wire frame, were a French speciality for which Nevers was famous in the seventeenth and eighteenth centuries. Large shadow-box scenes of a religious or secular nature were often made with these figures.

Domestic glass manufacture began to improve with the establishment of the famous Baccarat factory in 1765, which at first successfully imitated English styles, as did a number of other factories that started to make lead glass.

Figure of Christ, prepared glass rods melted and shaped over a copper wire armature. French, probably Nevers, late seventeenth century. Such work is known as lampwork since the rods are melted with a lamp. Lampwork techniques are still used for special glass laboratory equipment. H. 13 cm. 969.177.3



Cruche (jug for holy water). French, Provence, eighteenth century. H. 17.8 cm. 944.22.1

In Britain important glass production dates from the reign of Elizabeth I. Because of the increasing popularity of imported Venetian glass, a royal patent was granted in 1575 to Giacomo Verzellini to manufacture glass. The rare surviving examples of his work are mainly Venetian-style goblets of bubbly soda glass with crudely engraved inscriptions and family coats of arms. After Verzellini's retirement in 1592, a series of patents was granted to various entrepreneurs to import and manufacture glass; however, English glass of 1600-75 really cannot be distinguished from Continental. In 1615, a royal proclamation was issued forbidding the use of wood in glasshouses in order to prevent the deforestation of the country. Thereafter, coal was used for British glassmaking. During this period, calcined (ie., burned) flints were used as a source of silica but were eventually displaced by sand. This is apparently the origin of the term "flint glass".

About 1676, George Ravenscroft developed a lead formula glass that revolutionized the English industry. The red lead flux produced a clear glass of great brilliance. The glass cooled slowly and did not lend itself to tooled decoration. The early shapes were simple and solid like most of the tablewares of the times, and this taste continued to the eighteenth century.

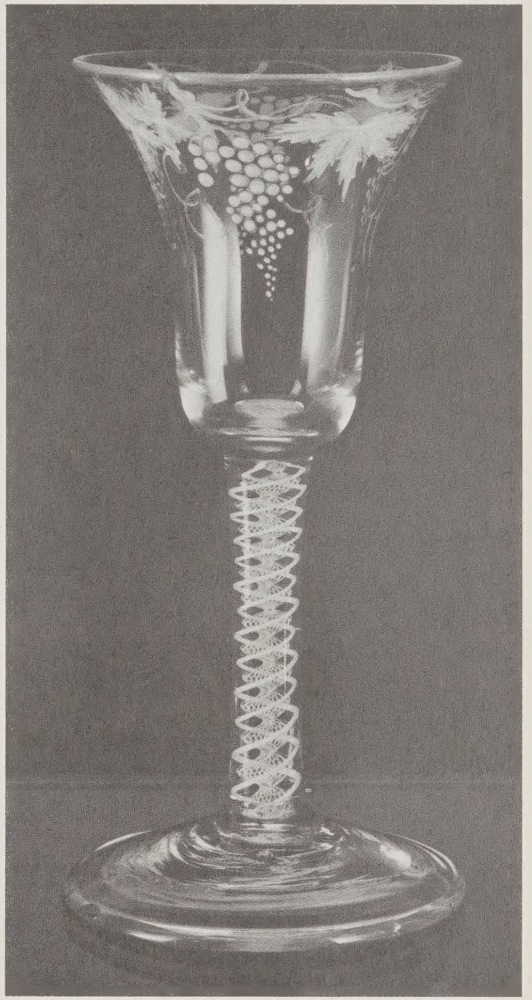
In 1745, Parliament began to levy a tax by weight on glassmaking materials. This tax, combined with the influence of the rococo style, resulted in lighter forms of vessels. The most varied designs are found among the drinking glasses, which include stems with

Glass wine bottles began to be made in England about 1650 and soon displaced ceramic ones. These three show the transition from the bulbous type, based on ceramic forms, to the long-necked cylindrical modern type which came in during the late eighteenth century. Left: shaft and globe type with griffon seal and owner's initials RP, ca. 1650-70. 928.17.10. Centre: onion-shape, ca. 1680-1710. 920.18.2. Right: mallet-shape, about 1750. The raised rim below the lip was for securing a paper seal by string. Gift of the Guildhall Museum, London. H. 22.7 cm. 939.9.174

facet cutting or with enclosed, twisted threads of opaque glass or air. Painted enamel decoration was occasionally done, notably by the Beilby family of Newcastle-upon-Tyne and in workshops in South Staffordshire, Bristol, and London.

By the late eighteenth century, clear lead glass with cut decoration became the ideal for tableware and light fixtures. English lead glass was exported and copied abroad. Coloured glass was produced in lesser quantities. When further excise taxes were imposed between 1770 and 1780, many glassworks moved to Ireland, which still enjoyed free trade status. But in 1825 the taxes were again increased and were applied to Ireland also. Irish cut glass is in most cases indistinguishable from the English. Both developed stylistically from the neo-classical shapes (e.g., canoe, urn) of the late eighteenth century to the heavier, more elaborately cut pieces of the early nineteenth century. From about 1810, clear and bottle glass novelties were spattered with chips or trailed with threads of coloured glass. Although these products were named for the glassworks at Nailsea near Bristol, similar items were produced by most British factories and occasionally in the United States.

Ale glass. Lead glass wheel-engraved with hops and barley symbolic of the ale. The folded-under foot is typical of pre-1745 English glass. 1740-45. Gift of Mrs. R.Y. Eaton. H. 14.8 cm. 937.13.115



Wine glass, clear glass with an opaque white twist stem. Painted white enamel grapevines and gilt lip. English, ca. 1765. Decoration attributed to William Beilby of Newcastle. Bequest of Mrs. Elizabeth B. Jones. H. 17 cm. 976.215.18

Canoe-shape dish, cut-lead glass. Foot pressed with lemon squeezer motif. Irish, Waterford, late eighteenth century. Gift of Mrs. J.R. Brett. H. 13.4 cm. 952.221

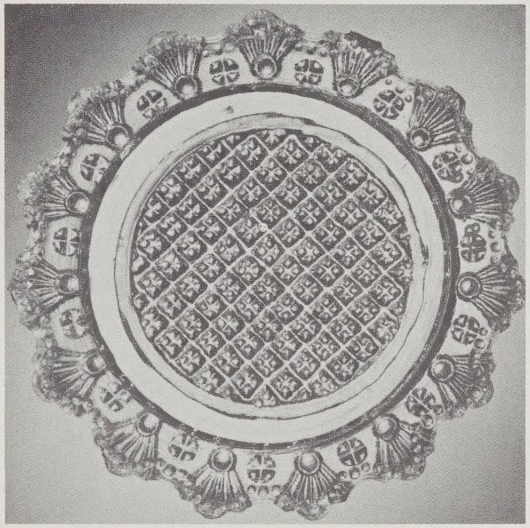
Jug, good quality cut-lead glass. English or Irish, ca. 1820-25. A type first introduced in the early nineteenth century. Bequest of Helen A. Boomer. H. 18.5 cm. 948.116.25

Decanter, dark blue glass. Sheffield plate and cork stopper. English, late eighteenth century - 1825. Such decanters, usually in pairs as this one is, were known as ship's or Rodney decanters. They concentrated the weight of the liquid at the bottom and were stable enough for maritime use. Gift of Miss Marie Tripp. H. 21.5 cm. 948.117.2c-d

Post-1800 Western Glass

The next advance in Western glassmaking was mechanization. Since Roman times, moulds had been used for blowing bottles and other vessels. Mould-pressed pedestal feet with a domed and ribbed "lemon squeezer" motif appeared in late eighteenth-century British glass, and the mechanical pressing of glass into moulds developed in the 1820s. Basically, a blob of molten glass was dropped into an iron mould and pressed with a plain plunger to fill the shape. The earliest documented use of this technique was in the Pittsburgh area of the United States about 1825. Drawer pulls and cup plates (coasters to hold the tea or coffee cup while the beverage was being drunk from the deep saucer) were among the first pieces to be pressed. Early pressed wares are distinguished by their heaviness, a plain interior where the plunger descended, a patterned exterior, and a sharp seam at the edge where the plunger and mould met. Improvements included the development of mechanical pressing techniques for larger pieces, the finishing of imperfections by fire-polishing, and the use of a growing range of colours. The patterns continued to imitate cut glass, but elaborate scroll and figural designs also came into use.

The development of English and Continental pressed glass is not yet as well documented as that of American glass. Early glass is seldom marked, but English pieces made after 1842 occasionally bear diamond-shaped registration marks, and after 1883, registration numbers. American examples sometimes have patent dates. Registration and patent marks indicated that the designs were copyrighted.



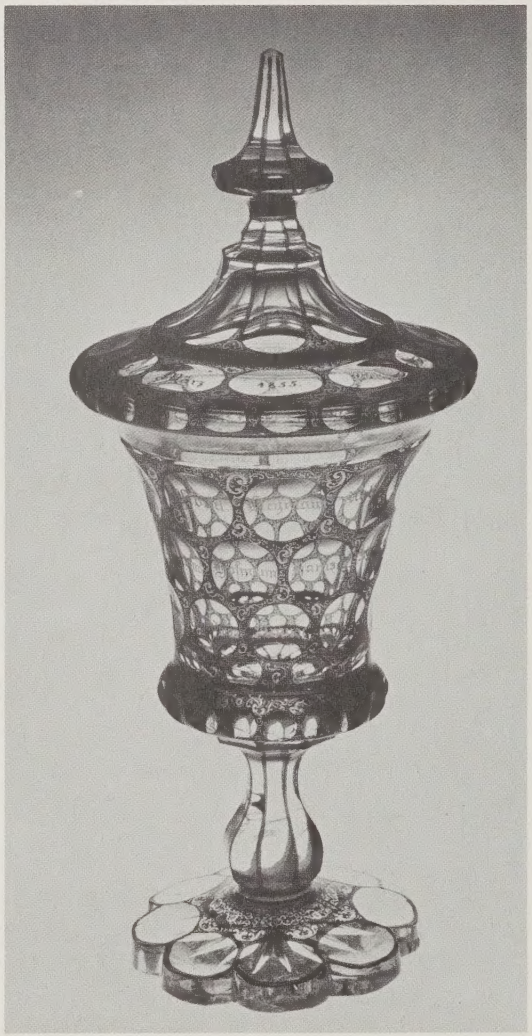
"Cup plate", pressed clear glass. Probably Boston & Sandwich Glass Co., Mass., U.S.A., about 1827-35. This was one of the earliest pressed patterns. Cup plates were used as coasters for the tea or coffee cup while the beverage was being drunk from the deep saucer. Diam. 8.5 cm. 948.88

Tub vase, mould-pressed light blue slag glass. Design of Sunbonnet Babies hunting birds' nests. English, Sowerby's Ellison Glassworks Ltd., Gateshead-on-Tyne, ca. 1882. Bequest of Mrs. Elizabeth B. Jones. W. 16 cm. 976.215.12

English pressed glass from about 1875 to 1905 is notable for its range of colours, which include opalescent and marbleized ("slag") tones. Many of these pieces are marked with the trademarks of Sowerby's, Henry Greener, and others. A great variety of pressed pieces copying luxury cut-lead glass appeared in the period 1880-1920.

Just as with pressed glass, the styles of hand-worked glass became increasingly international during the nineteenth century. Improvements in communications and transportation, the many trade exhibitions, and the emigration of glassworkers all brought about a greater uniformity in styles and technology. New trends in coloured glass and elaborate decoration began to appear in the 1820s. In France, opalescent glass in white, pink, blue, lavender, green, and yellow was produced in classical shapes from about 1820. By the 1850s-1870s, the shapes had become heavier and more elaborate, and the texture of the glass more opaque. Gilt and enamel floral decoration was often added.

Bohemian styles came to dominate fine glass in the mid-nineteenth century. By 1830, special coloured types were in production, such as hyalith, an opaque glass in red and black resembling sealing wax and onyx respectively, and lithyalin, a marbleized glass ranging from brick red streaked with green to dark blues and purples. Coatings of coloured glass known as "casings" and metallic oxides known as "stains" were extensively used to give colour effects. Translucent stains were painted on the surface of clear glass and made permanent by firing in a low-temperature kiln.



Covered goblet, clear glass with ruby staining and cut and engraved decoration. Bohemian, 1855. Bequest of Leo David Drucker. H. 32.2 cm. 970.253.36a-b

Stained and cased colours were frequently cut through to create colour effects against the body of the glass. They were also combined with gilt and polychrome enamel decoration. The styles of the time were eclectic and seem to have been influenced by the exports designed for Turkey, Persia, and India. The best of the Bohemian and Bohemian-style glass was extremely rich, reflecting its function as ornamental luxury ware. Bohemian styles influenced Continental, British, and American glass, particularly after the Great Exhibition of 1851.

The repeal of the glass taxes in 1845 made it easier for British manufacturers to vary their production, and coloured glass became more widely used. Most of the manufacturing was concentrated in the areas of Stourbridge and London. British mid-Victorian ornamental glass tended to simple and classical shapes, sometimes with elaborately scalloped rims. Thickly cased glass with cut decoration ("overlay glass") and opaque white and coloured glass with glossy or mat finish were enamelled and gilt. Pairs and sets of vases were popular.

The last two decades of the nineteenth century were distinguished by the great quantity of fine, hand-worked glasswares. These were mainly decorator and novelty pieces executed in subtle pastel colours. Oriental shapes and the stylized, asymmetrical decoration reflected a new Western admiration for Japanese decorative arts. The new styles were also in part a reaction to the rigid classicism and rich colours favoured during the middle years of the century and to the

mass-produced pressed glass. Such hand-worked glass was known as "art glass", and its production continued into this century.

Cameo-cut relief decoration inspired by Roman and Chinese glass was produced in France and England. The names of Stevens & Williams, Northwood, Emile Gallé, and Daum Frères are famous for these products. Special coloured effects were produced by English and American factories, and new types were introduced almost yearly during the 1880s.

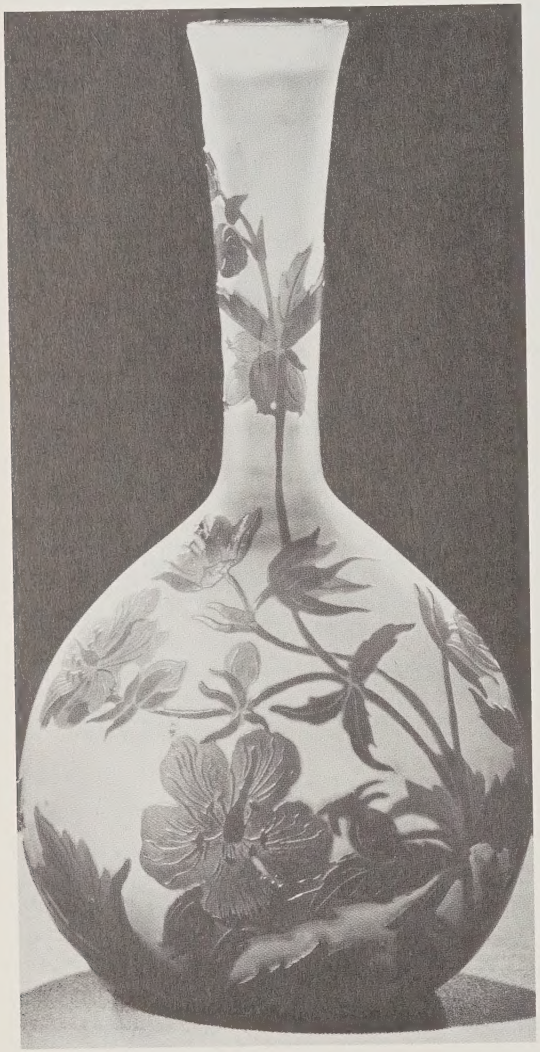
The use of chemicals in glassmaking became increasingly sophisticated. For instance, a satin finish was produced by exposure to hydrofluoric acid fumes, and this gave a mother-of-pearl effect when combined with internal air pockets that broke up the light. From about 1880, iridescent surfaces like those on ancient glass were produced by fumes of tin fluoride.

The most fashionable art glass of the period 1890-1910 was in the art nouveau style. It was free-flowing or sinuous in form and inspired by nature or by ancient glass. Louis Comfort Tiffany's glass, which frequently combined iridescent surfaces and loops of colour, exemplifies this style. Stained glass windows and light fixtures were also a manifestation of this style, although Tiffany Studios produced only a fraction of them.

By 1920, cleaner lines and more solid forms were favoured in glass. Colour was popular, particularly with an internal texture. The new designers such as René Lalique in France produced frosted, opal, and coloured glass in simplified classic forms. Internal cloudiness created by glass chips, metallic oxides, and bubbles was used to advantage by artists such as Maurice Marinot, Henri Navarre, Paolo Venini, Salvador Ysart, and others. Venetian glassmakers, who had revived earlier fashions in the late nineteenth century, continued to utilize traditional techniques and to apply them to simple modern forms.

From 1930 onwards, clear lead glass became the predominant fashion. Scandinavian glasshouses began to achieve international status with their production of lead glass, sometimes with engraving, and of subtly coloured wares. The English manufacturers have continued to produce fine conventional cut-lead glass while at the same time making limited art lines.

Rose bowl, coloured glass with tooled decoration. English, probably Stevens & Williams, Stourbridge, ca. 1880-1900. H. 10.8 cm. 973.301.3



Vase, "cameo glass" (maroon over pale pink and clear). French, Gallé Factory, Nancy, ca. 1900. Gift of Mr. Harry M. Buten. H. 16 cm. 956.37.1

Console table, plate glass with limed oak base. American, New York, ca. 1945. Glass has been used extensively for architecture and interior decoration from the 1920s onwards; this table is from a suite of three. Gift of Mr. O.D. Vaughan. H. 75.5 cm. 974.356.3a-e

Canadian Glass

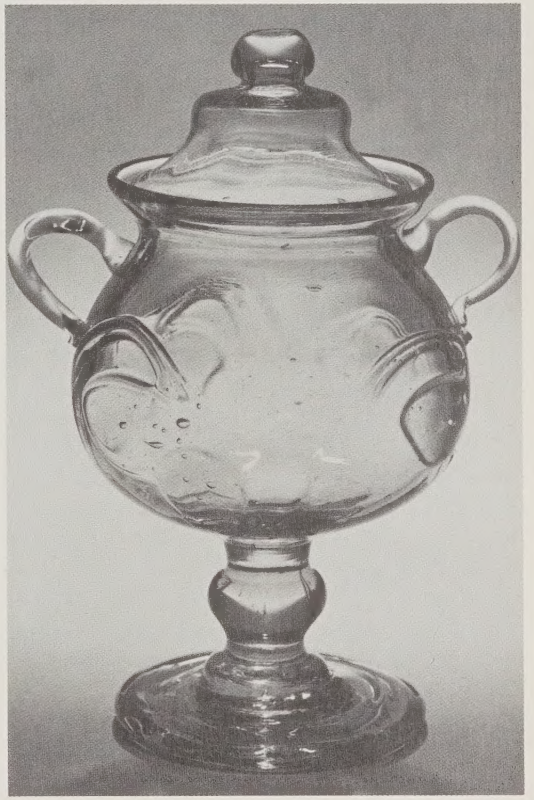
Like ceramics and other industries, early Canadian glassworks operated in a colonial economy, supplying utilitarian items such as window glass and bottles to meet local demand. Luxury glass and tableware were imported mainly from England and the United States. Many of the early factories survived for only brief periods, and name changes and mergers were frequent. The earliest glasshouse for which we have a record is that at Mallorytown in southeastern Ontario about 1839-40. A small number of American-style blown tablewares in pale aquamarine glass with tooled decoration are attributed to Mallorytown.

In the 1860s, the new railways opened larger markets to the glass factories. With the introduction of kerosene, many glassworks added lamps to their standard line of products. A growing population and a thirty per cent tariff on imports, introduced in 1879, further improved business. Containers often bearing the name of the customer or his product, and preserving jars following the model patented by John L. Mason in 1858, were an important aspect of the market.

The demand for lamps and tablewares grew quickly. After 1880, popular items included goblets, tumblers, cream pitchers, sugar bowls, butter dishes, spoon holders (bowls for tea spoons), water pitchers, celery vases, comports, salvers, plates, toothpick holders, open salt dishes, and shakers. Most of these were in clear glass, though colour was occasionally employed. Notable producers were the Burlington Glass Co., Hamilton, Ontario (1874-97), which introduced tablewares in the 1880s and by the 1890s was producing over 100 patterns; the Nova Scotia Glass Co., New Glasgow, N.S. (1881-92), and the various predecessors of the Dominion Glass Co., Montreal (1880-1913). It is sometimes difficult to attribute patterns to Canadian factories, because after 1891 they apparently acquired many of their pattern moulds from the United States Glass Company. Also, moulds travelled when Canadian companies merged. The Jefferson Glass Co., Toronto (1913-25), a branch of Dominion Glass, was a significant producer of later tablewares and of shades and lamps for the newly popular electric lighting.

Canadian glassworkers also produced whimsies—novelties which displayed the skill of the worker and were not part of the regular factory production. These served as presentation pieces and ornaments. Some of the whimsies produced between 1890 and 1925 include glass canes (often carried by glassworkers in Labour Day parades), animals, birds, hatchets, hammers, ships, darning eggs, and paperweights. Glass drapes to hang over bars and in parlours, composed of coloured and clear glass links, were another non-commercial Canadian product.

The popularity of cut-lead glass in the period 1880-1920 led to the establishment of cutting shops in Toronto, Ottawa, Montreal, and Winnipeg. "Blanks" for cutting were imported from France, Belgium, and the United States. The early designs were complex and geometric, while later ones tended to be simpler and floral, often with large sections of the design pressed into the blank. Canadian

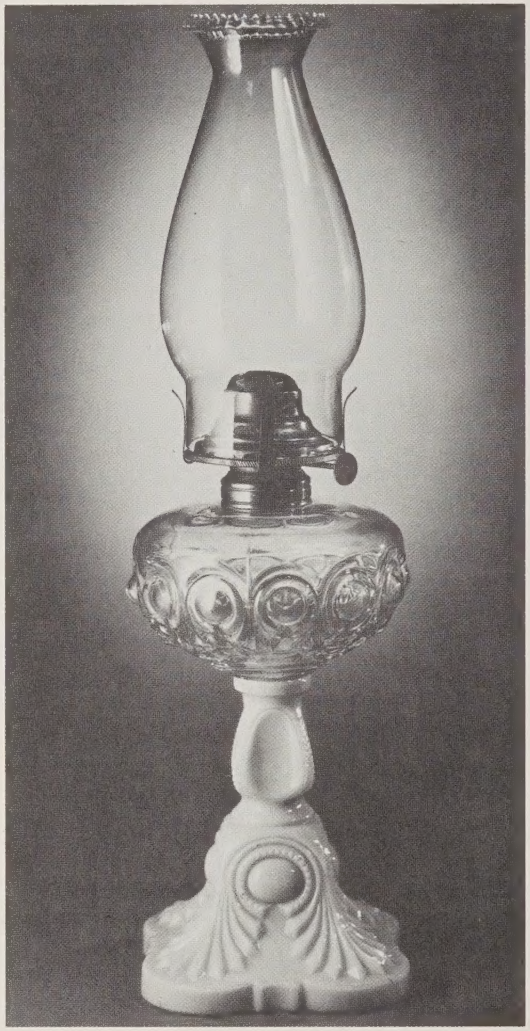


Footed bowl and cover, free-blown aquamarine glass. Tooled "lily-pad" decoration. Attributed to the Mallorytown glassworks, Mallorytown, Ontario, 1839-40. Gift of Mr. and Mrs. Gerald Stevens to the Edith Chown Pierce-Gerald Stevens Collection. H. 24 cm. 961.180a-b

pieces are identifiable by their distinctive patterns or by small frosted trademarks on the glass.

By 1920, lighter tablewares were coming into favour, and clear and pastel-coloured glass with needle engraving was being imported from Bohemia and manufactured in North America. This fashion was soon imitated by the machine-made Depression Glass, which was, in fact, produced from the 1920s until the early 1940s in massive quantities. Canada, too, turned increasingly to machine-produced glasswares. By 1930, most Canadian glass manufacturers were producing containers by machine, and tablewares had been largely phased out.

In the last decade, a studio glass movement has developed in both Canada and the United States. Craftspeople are being trained by community colleges, art schools, and other institutions, and many small workshops have opened. Most of the production so far is of heavy glass, usually with colour, in forms such as vases, paperweights, and goblets. These frequently reflect the influence of art nouveau designs in their trailed bands of colour and iridescent finishes. While the pieces of about 1970 were often tentative and lumpy, recent examples show a greater command of the medium and more concentration on improved form.



Footed lamp, mould-blown glass. Colourless chimney and font; foot of pressed blue opal glass in the "Bull's Eye" pattern. Diamond Glass Co., Montréal, ca. 1902. H. (overall) 47 cm. 967.190a-b

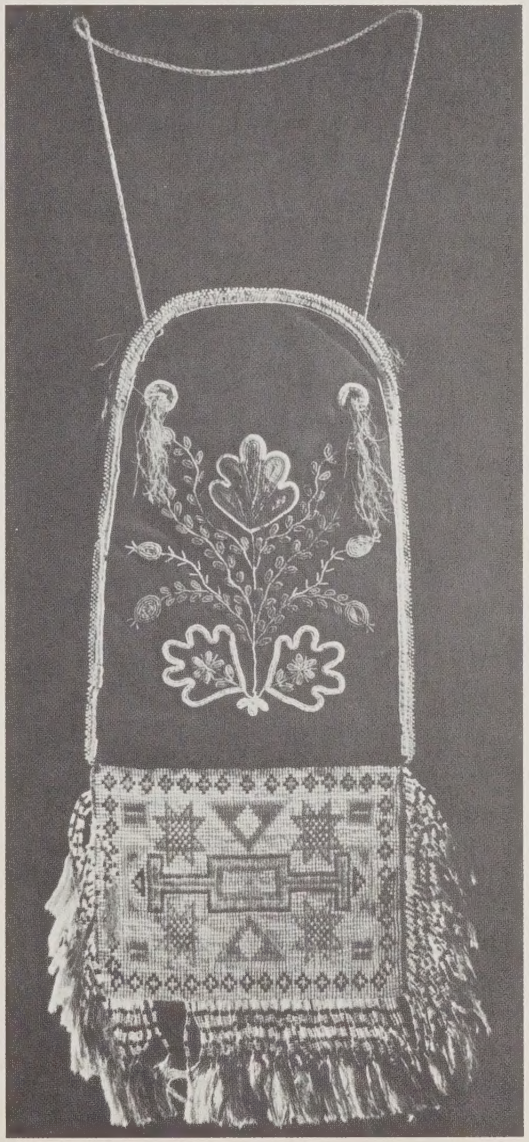
Comport with cover, pressed colourless glass. "Tulip & Sawtooth" pattern. Made by Burlington Glass Co., Hamilton, Ontario, ca. 1891-97. Also made by Bryce, Richards & Co., Pittsburgh, ca. 1854. Dominion Glass Centennial Research Foundation Collection. H. 31.7 cm. 970.154.3a-b

Beads and Beadwork

Glass beads are an interesting sideline to the study of glass. The beads discovered on archaeological sites can tell us much about patterns of trade. Beads are made in two principal ways. By the first method, a bubble of hot glass is drawn into a long slender tube which is then cut into the required lengths. Layered effects can be achieved by rolling the bubble in glass chips prior to stretching. A second method is to wind threads of molten glass over a wire which is withdrawn when the bead is completed. When cooled, beads can be filed down or tumbled and polished. Glass beads were an important part of Venetian production as early as the thirteenth century. By 1600, beads were manufactured elsewhere on the Continent and in England, although Venetian beads were still widely marketed.

During the Middle Ages, beads were used for rosaries and jewellery, and to highlight the details of embroideries. In the Renaissance, beaded embroideries became popular. The earliest surviving English examples date from the seventeenth century. High-quality beadwork was made throughout the eighteenth century, and looms and knitting techniques were developed that incorporated beads into the material. The scale of bead embroideries was much refined by technological improvements in the 1760s, which resulted in smaller beads and more brilliant colours.

A great deal of surviving beadwork dates from 1850-90, when large and coarse glass beads were combined with Berlin woolwork to decorate fire- and hand-screens, valances, cushions, footstools, and furniture upholstery. This late beadwork does not equal that of earlier periods in fineness or technique.



In native North American beadwork, imported glass beads were substituted for naturally occurring materials such as seeds, polished shell, porcupine quills, and moose and caribou hair coloured with natural dyes. Patterns tend to be geometric and floral. They can be woven on bead looms, embroidered bead by bead, or sewn on as woven strips, as on many hide objects and garments of the Plains Indians. In Africa, beads were used less elaborately and were mainly strung, combined into nets, or woven into coverings for containers. In the mirror embroideries of India and Indonesia, tiny discs of mirror are combined with embroidery. This fashion may have arisen from the use of mica plaques in embroideries or may be connected with the ritual significance of mirrors in these countries.

Fire-bag, floral design of glass beads on trade cloth. Lower panel of woven beads and rawhide. Beaded wool tassels. Cree or Ojibwa, ca. 1870. Presented to a Hudson's Bay Company factor on his retirement in 1870. L. 48 cm. 974.109

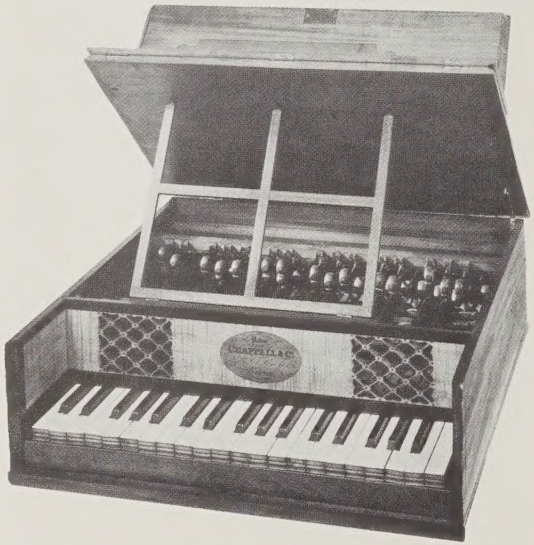
Novelties

Certain unusual or novel uses of glass are also of note. One of these is glass mosaic using fine glass chips or "tesserae". In the ancient Mediterranean world, mosaics were often used for floors, fountains, and niches. The range of coloured stone was expanded with coloured glass. The mosaics that decorated early Byzantine churches were created with glass tesserae backed with gold foil and set at angles for maximum effect. The dome of the Royal Ontario Museum's Main Rotunda is an excellent example of the Byzantine style. Mosaics in miniature were revived in Italy in the late eighteenth century, and the techniques were also copied by Russian workshops.

Glass paste (powdered glass heated in moulds until it vitrifies) was used by James Tassie, a Scottish sculptor, to produce portrait profiles and reproductions of antique gems in the late eighteenth century. Its use was revived by French glass artists in the first half of this century for sculpture and small articles.

Sulphides are unglazed porcelain sculptures enclosed in clear glass, which magnifies them and gives them a silvery sheen. This process was perfected about 1819 by Barthélemy Desprez Jr., a Parisian porcelain manufacturer. It was copied widely, notably by Apsley Pellatt in England, and certain pieces were produced with tinted porcelain in the 1850s.

Musical instruments with glass have been produced in a variety of forms. The most familiar is the wind chime. The Harmonium, a late eighteenth-century invention, produced notes when a finger was rubbed around the rim of glasses filled to different depths with water. This instrument was manufactured in Europe, England, and the United States. The Museum's glassichord is a table-top piano with blue glass rods in place of strings. It was sold by the well-known London firm of Chappell & Co. in the early nineteenth century.



Glassichord, mahogany case with ebony and satinwood veneer containing mechanical action with blue glass rods. English, early nineteenth century, by Chappell & Co., London. The R.S. Williams Collection of musical instruments. W. 57.6 cm. 913.4.85

Brooch, gilt filigree mounts holding a "sulphide". The sulphide is a ceramic robin on a snowy holly bough, enamelled in naturalistic colours and enclosed in lead glass. English, 1850-60. H. (overall) 5 cm. 970.99.1

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